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"Front Page" News

For the first time in history the foundry industry finds itself "front page" news in the popular Press. Apparently it has been discovered that the dearth of iron castings is a serious "bottleneck" in the reconversion of industry in general to peacetime activities. This is not altogether a misfortune, as it underlines the basic character of the foundry industry. What is unfortunate is the stress which the Press has placed on the dirty environment of shops in which castings are made. For years the Press has meted out similar treatment to the mining industry and has been the reverse of helpful in recruitment. Their attitude is to "pass the buck" back to the Government to release more men from the fighting services. The stressing of the unwillingness of ex-employees to return to the foundries is neither encouraging nor strictly truthful. The facts of the matter are that ex-machine minders from the armament industries are disinclined to take service in the foundry industry as the potential pay packet seems somewhat unattractive. There is but little recognition of the fact that from now onwards the foundry industry—by and large—enters a competitive era carrying new complexities. No longer is competition confined to rival concerns, but to rival industries. If rainwater goods cannot be supplied at an attractive price by the foundries, then the buyers will turn to asbestos cement. If components of gas cookers and the like exceed what the designer imagines to be a fair price he will rely on steel pressings, and so forth.

Another factor upon which sections of the Press have thought wise to comment is the notion that this last war, unlike earlier ones, was a "steel" and not a "cast iron" affair. The output of cast iron during the last few years has not been so very far short of peacetime production—despite the virtual closing down of those important sections catering for housing, textile, laundry and a dozen other industries. It seems germane to ask the popular Press just what the not inconsiderable wartime production was used for. It is impossible to forecast whether or not this newly awakened interest by the Press in our industry will be sustained, yet we hope not, because of the difficulty for the lay writer to get a well balanced appreciation of its structure. The sections of the industry now called upon for maximum production are the very ones which have been out of action for years. During this time they have been in a position to review their programme in the light of existing circumstances. The collapse of Japan has not taken them by surprise. They realised what they would be up against several years ago. That is why there are now—to quote official figures—28 schemes of major importance in progress for their immediate mechanised conversion.

The "bottleneck" is not the sole perquisite of the manufacturers of iron castings, and the construction can be traced further back to the foundry equipment industry, where the dearth of draughtsmen is acute. In earlier times, there was often something of a mass migration of labour from one type of foundry to another; for instance, after the last war the lighter textile foundries lost many men to the motor-vehicle shops. Nowadays, all are busy, so that reliance has to be placed on the training of recruits. We do not suppose that it would be very good "front page" news, but the daily Press could serve industry well by concocting a story that owing to the presence of dirt and the absence of over much cerebral competition in our industry, anybody with average intelligence is assured of a brilliant future! At least, one very prominent American foundry has stated that was the reason he entered the industry—and most certainly he has "made good."

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SCREW THREADS CONFERENCE

Sixteen Government officials and industrialists left London recently as a British delegation to the Conference on Unification of Engineering Standards which opens in Ottawa on September 24. This is the third in the series of conferences between Britain, Canada, and the U.S.A. which have been held during the past two years under the auspices of the Combined Production and Resources Board.

The delegation is headed by Mr. Stanley J. Harley, Technical Controller, Machine Tool Control, and the other members are:—Mr. Frederick H. Rolt (Director of Jig, Tools, and Gauges, Machine Tool Control), Capt. G. C. Adams, R.N. (Ministry of Supply and Admiralty), Mr. G. Howard Nash (Ministry of Aircraft Production), Mr. Norman R. K. Wheatley (Ministry of Aircraft Production), Mr. J. E. Sears (Department of Scientific and Industrial Research), Mr. Douglas G. Sopwith (Department of Scientific and Industrial Research), Sir William A. Stanier, F.R.S. (British Standards Institution), Mr. Percy Good (British Standards Institution), Miss G. E. Harrison (British Standards Institution), Mr. James E. Baty (British Standards Institution), Mr. George A. Whipple (Scientific Instrument Makers' Association), Mr. Theodore K. Affleck (Society of Motor Manufacturers and Traders), Mr. Clement M. Holloway (Society of British Aircraft Constructors), Mr. Henry E. Lane (Ground Thread Tap Association and Cut Thread Screwing Tool Manufacturers' Association), and Mr. James S. Blair (Stewarts and Lloyds, Limited).

During the fortnight the conference is scheduled to last, there will be 15 sessions, and the subjects to be discussed will include truncated Whitworth threads, pipe threads, Acme threads, buttress threads, instrument threads, rolled sheet metal threads, solid round threads, high duty studs, unification of screw threads, outlet threads on gas cylinders, screw thread symbols, screwing tools, limits and fits, and drawing practice.

NEW SCOTS FACTORIES TO MAKE STEEL HOUSES

Five new factories are to be started in Scotland for the mass production of pre-fabricated steel and aluminium houses. The estimated cost of Scotland's 10-year housing programme is £500,000,000. G. & J. Weir, Limited, Cathcart, Glasgow, are opening a factory in Coatbridge to produce 1,500 steel houses a year, while the Atholl Company are already in production in Glasgow, and aim at an output similar to that of Weir's.

The Scottish Orlit Company is planning new factories in Edinburgh and the West. The site for the Edinburgh premises has been obtained and Coatbridge is likely to be the location of the West of Scotland enterprise. The Orlit, Weir and Atholl companies have already received contracts valued at £1,600,000.

Mr. George Buchanan, Under-Secretary for Scotland, has visited the Blackburn Aircraft works at Dumbarton, where the prototype aluminium house is now in course of construction.

SUBMARINES BUILT BY INLAND FIRMS

The story may now be told of how a group of three firms undertook, in 1942, to construct a miniature type of submarine, known as "X" craft, under conditions of the utmost secrecy.

The principal company engaged was Thomas Broadbent & Sons, Limited, of Huddersfield, whose Central Ironworks turned out the first of these four-man submarines in October, 1943. The group was made up by Markham & Company, Limited, Chesterfield, and Marshall, Sons & Company, Limited, of Gainsborough.

It will be noticed that all these firms are situated well inland, and naturally had no earlier experience of shipbuilding. Another noteworthy point is that, with the exception of instruments and scientific articles, the submarines were constructed and fitted out completely by the individual firms.

The exploits of the flotilla containing the "X" craft are numerous, and include the damaging of the German capital ship "Tirpitz." Harbour installations were blown up, and merchant ships, thought to be at safe anchorages, were "mysteriously" destroyed. No fewer than 24 decorations were earned by members of the flotilla, including two Victoria Crosses. The men who received them paid tribute to the reliability and magnificent quality of their craft.

FOUNDRY TRADES' EQUIPMENT & SUPPLIES ASSOCIATION

The annual meeting of the Foundry Trades' Equipment and Supplies Association was held at the Waldorf Hotel, London, W.C.2, on September 13. Under the new articles of association, which were agreed to, the following were elected members of council:—Mr. R. H. Brackenbury (Sterling Foundry Specialities, Limited); Mr. V. C. Faulkner (Editor of THE FOUNDRY TRADE JOURNAL); Mr. G. E. France (Augusts, Limited); Mr. T. A. Hammersley (Marco Conveyor & Engineering Company, Limited); Mr. D. Cherry Paterson (Paterson, Hughes Engineering Company, Limited); Mr. W. R. Rawlinson (J. W. Jackman & Company, Limited); Mr. A. C. Turner (General Refractories, Limited); Mr. D. H. Wood (Constructional Engineeering Company, Limited); and Mr. H. Winterton (Wm. Cumming & Company, Limited). At a council meeting which followed Mr. Paterson was re-elected president and Mr. Rawlinson vice-president.

FRENCH FOUNDRY COMMISSION HERE

A Commission representing the French foundry industry is at present visiting this country. It is headed by Mr. R. Christa and other members of the Commission include Mr. Bardot (magnesium), Mr. Dufour (iron), Mr. Horman (steel), Mr. Laffly (aluminium), and Mr. Petit (iron). Contact can be made with the Commission by writing to them at 10, Sterling Street, Montpelier Square, London, S.W.7.

LIEUT.-COL. R. B. LEECH has been elected a director of the Albion Drop Forgings Company, Limited.

HIGH TENSILE STEEL FOR CASTINGS*

By W. WEST, C. C. HODGSON and H. O. WARING

Analogies with forged steel provide useful pointers for progress

The types of steel dealt with are of the low and medium alloy varieties, capable of giving ultimate tensile strengths from 35 to 65 tons per sq. in. on sections up to 4 in., or as high as 75 tons per sq. in. on smaller sections, accompanied by good ductility and resistance to impact. It is proposed to deal broadly with the steel-making practice, and the influence of chemical composition on mechanical properties and heat-treatment, and to include some notes on sands and methods of feeding. The steels around which these notes are written include carbon manganese steel containing small amounts of nickel, chromium, and molybdenum (referred to in the Paper as "residual alloys"), which, together with the manganese present, resulted in a steel approximately equivalent to a straight carbon steel containing 1½ per cent. manganese; manganese-molybdenum (1½ per cent. Mn), and chromium-molybdenum (1 per cent. Cr) containing similar amounts of residuals; non-standard steels containing rather larger amounts of residuals; and 2½ per cent. nickel-chromium-molybdenum steels.

Plant and Equipment

The Authors were not particularly fortunate in the steel-making furnaces available; these consisted of basic-lined electric-arc furnaces with conducting hearths, one a Greaves-Etchells, and the other an Electro-Metals. These had many years' service to their credit, and had been standing idle for a period of about five years prior to the outbreak of war.

The conditions for steel making were less favourable than in more modern furnaces, and particular care was needed to ensure the high quality of steel required. On the heat-treatment side conditions were more favourable, as a number of modern furnaces of different types were available. Sand handling during the period covered by the Paper was on the batch principle, but the foundry is now being mechanised for reclamation, milling, and conveying.

Steel-making Practice

The turnings and scrap used come from the engineering departments of the company with which the foundries are associated, and carry a certain amount of alloying elements which remain in the steel after melting. The nickel content in the bath usually varies between 0.5 and 1.0 per cent., and the steel after slagging also carries small amounts of chromium and molybdenum. For many foundry purposes these residual alloys would be considered a distinct disadvantage, but for the type of work discussed here they have proved to be helpful. The charges consist of three types of material, foundry scrap (headers, etc.), medium and light weight steel scrap, and turnings, used in approximately equal amounts.

Generally speaking, there are two ways of operating basic electric-arc furnaces working on the two slag process. One method is to melt the charge and boil out the carbon to the required figure and remove the oxidising slag before any deoxidising additions are made. The other is to start the "killing" reactions by adding some form of deoxidiser (generally ferro-manganese or silico-manganese) before the oxidising slag is removed. The Authors have used both processes extensively, and experimented with several variants of the second one, and, whilst they agree that excellent steel can be made by either process, it is their experience that steel of the highest quality is more likely to be obtained consistently when deoxidation is commenced early in the heat than when left until after the oxidising slag has been removed, or the second slag added.

FIG. 1.—SHOWING A DEFECT, THOUGHT TO BE ANALOGOUS TO FLAKING IN STEEL FORGINGS.

As far as possible all operating conditions have been standardised, commencing with the make up of the charge, through melting and refining to teeming. Whatever method is used the correct place to deoxidise basic-electric steel for castings is in the furnace, and no amount of subsequent dosing will fully make up for deficiencies there; conversely, if the job is done properly in the first place the steel does not need dosing afterwards. The addition of aluminium to the metal as it leaves the ladle is not permitted; the practice still has its uses, but so far as basic electric steel for castings goes it is an anachronism.

* A Paper read before the Lancashire branch of the Institute of British Foundrymen, Mr. Stanley Brooks presiding. The Authors are on the staff of Leyland Motors, Limited.

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Hydrogen and Flakes

The phenomenon variously referred to as hair-cracks, flakes, and snow flakes is sometimes met with in forgings made from alloy steels. According to the literature there may be many causes for this defect, and workers in that field are by no means unanimous about the real cause, but the majority of informed opinion inclines to the view that it is to be attributed to the presence of hydrogen in the steel. The Authors have occasionally found tensile test-pieces representing alloy steel castings to exhibit a peculiar bright patch in the fracture which appears to be a defect in steel castings analogous to flakes in steel forgings. A typical fracture of the type referred to is shown in Fig. 1. The serious way in which the properties of the steel can be affected are well illustrated by the results in Table I.

TABLE I.—*Mechanical Properties ob ained from Test-pieces showing Flaked and Sound Fractures. Cast A*3028. C 0.21; Si 0.45; Mn 1.58; S 0.012; P 0.020: Ni 0.75; Cr 0.13, and Mo 0.28 per cent. Specimens 1½ in. × 1½ in. × 4½ in. Normalised 900 deg. C. Oil-hardened 850 deg. C. Tempered as shown.

Tempered.	550 deg. C.		600 deg. C.	
Fracture.	Flaked.	Sound.	Flaked.	Sound.
Y.P. (tons per sq.in.	—	47.7	35.6	40.0
U.T.S.(tonsper sq.in.	45.4	54.4	44.2	48.0
E. per cent.	2	14	5	18
R/A. per cent.	10	26	20	40
Izod, ft. lb.	—	18, 17	—	42, 40
U.T.S. E.	47.4	68.4	47.2	66.0

In considering measures to be adopted for the elimination of this defect it was assumed that it was a manifestation in alloy steel castings analogous to the flakes in steel forgings. Working on the most favoured opinion that such defects were due to hydrogen, it became necessary to consider the means by which excessive amounts of hydrogen might find their way into the steel, and to take steps to prevent this, or to remove it. The slag-making material used at this time was burnt lime; as it is almost impossible to prevent a certain amount of hydration taking place, such lime could have carried hydrogen into the steel. The defect occurred most often in steels in which the carbon was fairly high, and in heats which had not received much boiling during the oxidation stage.

Two factors were investigated, burnt lime was replaced by limestone, and the steel was boiled vigorously so as to bring the carbon in the bath to a figure not exceeding 0.15 per cent. before slagging. When these measures were adopted the defect disappeared. Limestone gives rise to the evolution of a large amount of carbon dioxide gas, and in making the second slag the rapid evolution of this large volume of gas caused a certain amount of discomfort to the furnace crews, it was decided, therefore, to return to the use of burnt lime, but to continue boiling out to a carbon content around 0.1 per cent. When this procedure was adopted there was no further appearance of the bright, shiny type of flake or fissure, from which it was concluded that the vigorous boiling during the oxidising stage had eliminated the cause of the defect, and that the use of burnt lime, even if somewhat hydrated, had no adverse effect in this direction when used for the making of the second slag.

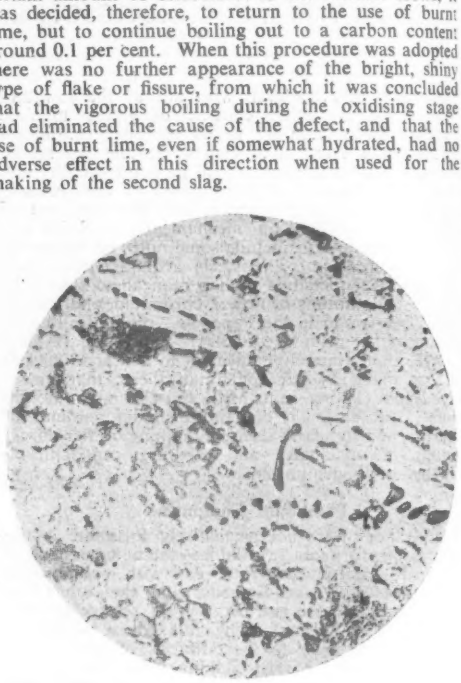

FIG. 2.—SHOWING INCLUSIONS EXISTING IN CAST No. B1626 (TABLE III). × 500 DIAS.

ALUMINIUM ADDITIONS

(1) Control of Inherent Grain Size

The advantages of a controlled inherent grain size have long since been recognised in connection with wrought steel because of the vast amount of work which has been done following the initial investigation of McQuaid and Ehn on "abnormality,"[1] and for most purposes a fine inherent grain size is preferred. The importance of inherent grain size in steel for castings has not received anything like the same attention. The Authors' experiments were made at a time when the castings were supplied in the annealed or normalised and tempered conditions.

A knowledge of the McQuaid-Ehn grain size may be of value as an indication of the probable behaviour of the steel under a given set of conditions, but it is important to know the effect of variations in steel-making practice on the structure of the steel in the

condition in which it will be used. Usually, the smallest grain size and the most uniform distribution of pearlite and ferrite grains are desired. The grain size depends chiefly on the temperature of treatment, rate of cooling, and austenite-coarsening characteristics of the steel. The even distribution of pearlite and ferrite is directly related to the homogeneity of the steel, the segregation which takes place during the solidification of the steel usually leads to uneven distribution of the ferrite and pearlite after annealing, the slower the cooling after annealing the more pronounced the separation into pearlite-rich and ferrite-rich zones.

For some purposes a large addition of aluminium has been advocated as a primary deoxidiser; the Authors' experiments compared such an addition with ladle additions and with heats to which no aluminium was added. The conditions were, no aluminium addition; additions of 1 and of 3 lbs. per ton added to the metal stream in the ladle, and the addition of 6 lbs. per ton added under the oxidising slag immediately before slagging. The McQuaid-Ehn grain sizes, determined under standard conditions, are shown in Table II.

TABLE II.—*Effect of Aluminium Additions on McQuaid-Ehn Grain Size*

Cast Serial.	Aluminium Additions.	McQuaid-Ehn Grain Size.
2976 2981 3038	No aluminium addition.	4 and 5, predominating, a little 2, 4 and 5 predominating, a little 3, 4 and 5 predominating, a little 3.
2989	1 lb. per ton added to metal stream in the ladle.	4
3034		4 and 5 in about equal amounts.
3148	3 lb. per ton added to metal stream in the ladle.	7 predominating, a little 8.
3150		7 predominating, a little 6.
3170		5 and 6 with a little 4.
3171		6 with a little 5.
3001	6 lb. per ton added to the metal under the oxidising slag as primary deoxidiser.	7 and 8.
3031		7 with a small amount of 5 and 6.
3166		7 with a little 6.
3168		7 with a little 8.

When the structures of the annealed steels were examined under the microscope it was easy to draw a distinction between steel to which, on the one hand, none, or only a little, aluminium had been added, and, on the other, steel to which relatively large aluminium additions had been made; but it was not possible to distinguish between heats to which 3 lbs. per ton of aluminium had been added in the ladle or 6 lbs. per ton added in the furnace; sometimes the one and sometimes the other gave the finer structure. There was no doubt about the influence of 1 lb. per ton and 3 lbs. per ton added to the ladle; the latter gave the smaller individual grains of pearlite and ferrite, although there was not much to choose between the two in the matter of general arrangement and size of the cellular formation of ferrite "kernels" and pearlite network in instances where this was the type of structure present.

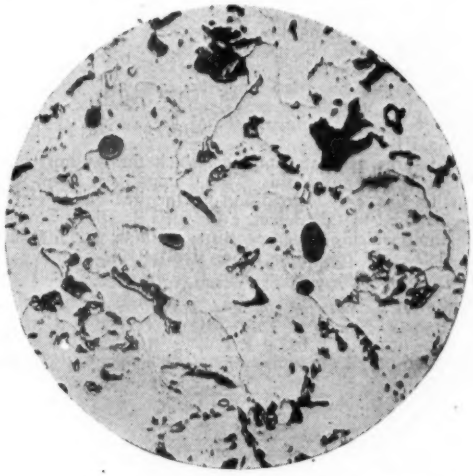

FIG. 3.—SHOWING INCLUSIONS EXISTING IN CAST NO. B1628 (TABLE III). × 500 DIAS.

Concurrently with this work the influence of these additions on mechanical properties was determined, and without going into the results of this work in detail, the conclusions were that the use of 6 lbs. per ton of aluminium as a primary deoxidiser, without any subsequent additions, caused the steel to be slightly tougher than steel of similar analysis to which no aluminium had been added, or to which 1 lb. per ton had been added in the ladle; but when comparing the addition of 6 lbs. per ton used as primary deoxidiser with 3 lbs. per ton added in the ladle a distinct advantage in favour of the ladle additions was indicated.

The general conclusion, therefore, was that a large ladle addition of aluminium to basic electric steel is an advantage in helping to produce a fine grain size and in increasing toughness, and, in general, produces

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results which are superior to those obtained when an even larger addition is used as a primary deoxidiser at an earlier stage in the steel-making operations.

(2) Control of Sulphide Distribution

The preceding experiments were made without reference to the previously published work on the influence of aluminium additions on the nature and distribution of sulphide inclusions, and it is a remarkable coincidence that the addition decided on, 3 lbs. per ton, is around the optimum for obtaining high ductility. Most steel founders must occasionally have had the misfortune to make a cast of steel which was later found to possess ductility less than that usually associated with its ultimate tensile strength. The condition does not persist after forging; steels of similar analysis which vary markedly in ductility in the cast and annealed and the cast and normalised conditions usually possess almost identical ductility after forging, as illustrated by the results shown in Table III.

No form of heat-treatment which the Authors have found will remove this "dry" condition from steel in the "as cast" condition if the heat of metal is predisposed to this defect, even such drastic treatments as homogenising at temperatures as high as 1,100 deg. C. left the low elongation steel B1626 (shown in Table III) almost unaffected. It is now fairly generally

TABLE III.—*Comparison of Two Steels Giving "Dry" and Ductile Fractures. Cast B*1626. C 0.21; Si 0.22; Mn 0.90; S 0.033; P 0.027; Ni 1.00; Cr 0.12; Mo 0.09, and Cu 0.09 per cent. *Cast B*1628. C 0.18; Si 0.19; Mn 0.90; S 0.029; P 0.020; Ni 0.98; Cr 0.13; Mo 0.11; and Cu 0.19 per cent. Normalised 900 to 925 deg. C. Tempered 640 deg. C.

Condition.	Castings*.		Forgings.†	
Cast No.	B1626	B1628	B1626	B1628
Y.P. (tons per sq. in.)	24.0	23.0	27.8	26.8
U.T.S.(tonsper sq.in.)	32.0	31.6	35.2	33.4
E per cent.	19	31	32	33
R/A per cent.	—	—	63	69
Izod, ft. lb.	—	—	68/67	75/80

* Test-bars 1½ in. × 1½ in. × 4½ in. when heat-treated.
† Test-bars ¾ in. dia. when heat-treated.

agreed that this type of defect is due to the difference in size and arrangement of the non-metallic inclusions present, particularly the sulphide inclusions. Typical inclusions on cast numbers B1626 and B1628 are shown in photomicrographs (Fig. 2 and Fig. 3) each at a magnification of 500. The metal-inclusions interface area in the former must be many times that in the latter, for example, about 1,000 of the smallest inclusions shown in Fig. 2 could be packed into the largest of the inclusions shown in Fig. 3, and would, of course, have a surface area about 1,000 times as great.

This connection between the distribution of the non-metallic inclusions and the ductility of the steel was referred to at some length by Sims and Lillieqvist[2] as long ago as 1932, and since then a considerable amount of work has been done on the subject, notably

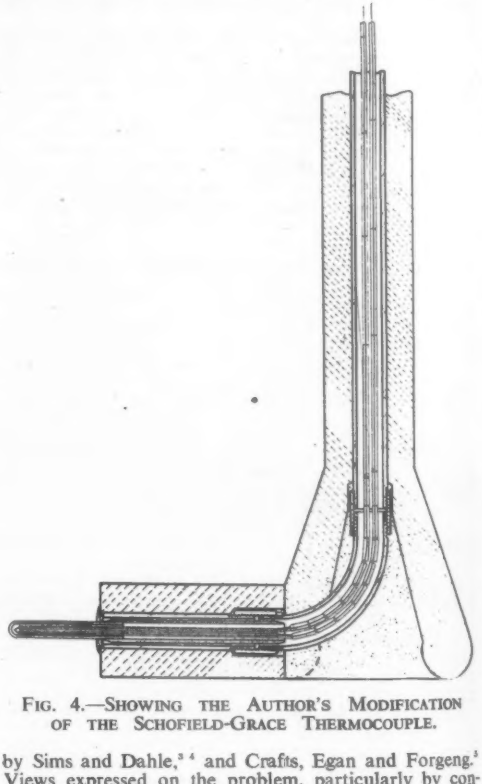

FIG. 4.—SHOWING THE AUTHOR'S MODIFICATION OF THE SCHOFIELD-GRACE THERMOCOUPLE.

by Sims and Dahle,[3,4] and Crafts, Egan and Forgeng.[5] Views expressed on the problem, particularly by contributors to discussions, are by no means unanimous, but it does seem that in the matter of adding aluminium to well-killed steel for castings, either it should be given none or it should be given a really good dose. There appears to be slight evidence that an addition of calcium-silicon at the same time as a large addition of aluminium is beneficial in producing the right kind of non-metallic inclusion. The melting procedure adopted by the Authors (originally for reasons which had nothing to do with the distribution of inclusions)

is the same as that recommended by some of the American workers referred to in their work on inclusion distribution and ductility. The Authors can confirm that with their present methods of slag making and finishing, test-pieces possessing a "woody" or "dry" fracture are very rare occurrences, and when found can generally be associated with something slightly abnormal in the slag condition. Whether this is to be interpreted as meaning that this has altered the amount of aluminium entering the steel the Authors have not investigated.

In connection with this and allied problems it would be most helpful if there were available really satisfactory methods for the determination of small amounts of aluminium and alumina in steel. Some analysts may be inclined to protest that such methods do exist, but it is the Authors' experience that if this be so knowledge of them is not very widely disseminated.

Temperature Measuring

Empirical methods for assessing the temperature of molten steel can yield good results when used by experienced observers, but it is recognised that more exact methods are desirable, and during the last few years much attention has been paid to methods suitable for measuring the temperature of molten steel, notably by the Liquid Steel Temperature Sub-committee of the Iron and Steel Institute Heterogeneity Committee.[6,7]

Optical pyrometers are useful instruments for determining temperature after the metal has left the furnace; they are not satisfactory for temperature measurements of the metal in the furnace, although it is obviously of more importance to know the temperature at this stage rather than at some later stage when nothing can be done to increase the temperature of the metal and it is possible to take steps which are capable only of reducing the temperature.

It now seems fairly well established that the most satisfactory thermocouple for use in steel-melting furnaces is the platinum, platinum-rhodium combination. A considerable step forward has been achieved by Tinsley Industrial Instrument Company, who have developed an apparatus which amplifies the small e.m.f. produced by the couple, and enables the temperature to be recorded by means of a pen and ink mechanism on a quickly moving chart.[8]

The thermocouple e.m.f. operates a mirror galvanometer, and the beam of reflected light falls on a photocell. The degree of illumination of the photocell controls the rectified current output of a thyratron valve, and by an ingenious manipulation of this current in a resistance in series with the galvanometer, it is rendered proportional to the input voltage (*i.e.*, the e.m.f. of the thermocouple). The anode current through the thyratron valve is supplied from a 250-volt section of a mains transformer, and it is used to operate a robust moving-coil type galvanometer with the pen-and-ink mechanism recording on the moving chart. The amplification is independent of mains fluctuations, characteristics of valves, and other components. The apparatus is reliable, and requires only slight periodical adjustments which can be carried out quickly and checked. The temperature of molten steel can be measured in 5 to 10 secs.

FIG. 5.—SHOWING THE USE OF GRAPHITE SLEEVES FOR PROTECTING THE THERMOCOUPLE.

FIG. 6.—SHOWING THE USE OF THE THERMOCOUPLE IN PRACTICE.

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Facilitating Repairs and Maintenance

An important necessity for practical application of temperature measuring with an immersion thermocouple is to have this designed from the materials which are readily available and constructed in such a way that repairs and maintenance can be quickly and cheaply done. The Authors have developed such a thermocouple covering which can be made from materials which are to be found in most foundries or are readily obtainable. The general arrangements can be seen from Fig. 4. It is essentially a modification of the Schofield-Grace thermocouple.[6]

When first made up the thermocouple consists of 4 ft. each of Pt. and Pt.-Rh. wires silver soldered to compensating leads, about 3 ft. of which are stripped of their covering and threaded through twin bored fireclay insulators. The rare-metal wires are both covered throughout their length with fine, transparent, fused-silica tubing and, in addition, excepting the last 8 in. or so from the hot junction, are enclosed in one length of ordinary hard glass tubing. This tube is plugged at each end with ignited asbestos to protect the rare-metal wires from contamination as much as possible.

The thermocouple and part of the compensating leads are enclosed in $\frac{1}{4}$ in. dia. thin-walled steel tube of suitable length, which is bent over at one end or may have a detachable 90 deg. bend affixed. Whichever method is adopted the bend should be of sufficiently large radius to allow the thermocouple wires and insulation to pass round the bend easily. With this arrangement the thermocouple can be easily withdrawn at any time for examination and replaced in a few minutes. The steel tube is covered with a Morgan graphite plunger-mixer as used for non-ferrous metal mixing. These sleeves have an enlarged end which is convenient for providing a substantial covering for the bend in the steel tube. The portion of the steel tube which has to be immersed in the steel is protected by a block of the same graphite material, or electrode graphite may be used (see Fig. 5). This may be screwed or wedged on to the short verticle end of the steel tube. This portion of the tube is also lined with $\frac{1}{4}$ in. bore, thick-walled, fused-silica tube fastened in with Purimachos cement.

The thermocouple is pushed into the steel tube until 2 in. protrudes at the hot junction end, and this is covered with a thin transparent silica sheath cemented into the inner lining (fused-silica) of the end piece. The whole requires very little maintenance. The silica sheath can be renewed in a few minutes, and one set of the graphite sleeves will stand up to a few hundred temperature determinations. The short length of graphite which enters the slag will withstand 50 to 60 immersions if made of electrode graphite. The thermocouple is shown in use in Fig. 6.

The couple complete weighs about 18 lbs., and is easy to handle. It is important in using the apparatus that the thermocouple should be lowered into and raised from the bath with a vertical movement. If an attempt is made to move the thermocouple in the bath, or to drag it from the metal by a combination of horizontal and vertical movement, the resistance of the metal will bend the transparent fused silica sheathed end, which makes it necessary in most instances for the couple to be remade as the insulators may be broken when the silica sheath is removed. With careful use two readings may be obtained from one transparent fused silica sheath, and 20 readings may be obtained from one hot junction before it is necessary to remake this. When doing this, half an inch of the platinum couple is cut away before re-fusing the hot junction. The rejected portion of wire constitutes valuable scrap.

It is perhaps hardly necessary to add that conditions for determining the temperature in the bath must be carefully standardised. Once the most satisfactory methods as regards stirring of the metal before the immersion of the thermocouple, the position in the furnace in which the thermocouple is placed, and other factors more or less governed by domestic conditions have been determined, they should be rigidly adhered to. It is not convenient or economical to take a large number of readings on one heat, but, should the temperature in the first instance be too low, it is possible after a little experience to estimate the length of time and the rate of power input which it is necessary to apply before the steel will have attained approximately the desired teeming temperature. By this method it is possible to approach consistently to within 10 deg. C. of the desired teeming temperature.

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(To be continued.)

TWO SOUND FILMS, "The Unfinished Rainbow" and "Casting in Hiduminium-aluminium Alloys," will be shown at a meeting of the Bristol and West of England branch of the Institute of British Foundrymen at the Grand Hotel, Bristol, at 3 p.m. on Saturday.

MR. J. W. GARDOM, president of the Institute of British Foundrymen, will present a Paper on "Mechanisation with Respect to the Light Castings Industry" to the Falkirk section of the Institute on September 28. The meeting will be held at the Temperance Café, Lint Riggs, Falkirk, at 7 p.m.

MALLEABLISING IRON CASTINGS

This article discloses a development in technique which has found much favour in the U.S.A.

By J. FALLON

Throughout the heavy and light industries, both ferrous and non-ferrous, the development and application during the last 10 years of the radiant tube bell furnace has perhaps been the greatest contributing factor in the attainment of precision control and protection of surface finish, coupled with extreme economy in fuel consumption.

In Great Britain alone, Lee Wilson bell-type units, having a total capacity of over one million tons per year, have been placed into successful operation for handling a wide range of metallurgical products with capacities ranging from a few tons to 200 tons per single charge, thus providing substantial evidence on a large scale of the acceptance by the industries concerned of the practicability and high efficiency of this system.

Only during the last three years has the attention of Lee Wilson designing engineers been applied to the vital thermal problems of the malleable-iron industry, with outstanding results in control, economy, cleanliness and costs to such a degree as may well revolutionise present concepts governing the annealing cycle in this important and vital industry.

Main Features

The main features of this development may be characterised as follows:—

(1) The application of a sealed radiant tube heated bell-type furnace, for malleable-iron castings, in such manner that the castings are used to create their own protective atmosphere and to avoid scaling during the process of annealing.

(2) The furnace shows great flexibility in dealing with malleable castings of a wide range of compositions as met with in the United States. Whilst total carbon content is usually about 2.5 per cent., silicon contents may vary between limits of 1.5 to 3 per cent., and even as high as 4 per cent. In the higher silicon irons, the distribution of temper carbons throughout the structure is facilitated and annealing time reduced.

(3) Packing materials and annealing pans, which rapidly deteriorate and often exceed the weight of the effective load of castings, are eliminated.

(4) The bell-type radiant tube furnace provides facilities for effecting rapid air-quench, equalisation and progressive slow cooling under absolute control, which cycle is essential for production of malleable castings of high physical properties, both in general structure, tensile strength and elongation. In the conventional system in which castings are packed in iron ore, scale, etc., in pans, it is quite impossible either with batch or continuous practice to process the castings through the cooling phase under control and at rates now accepted as essential for the attainment of the higher physical properties demanded by the user industries.

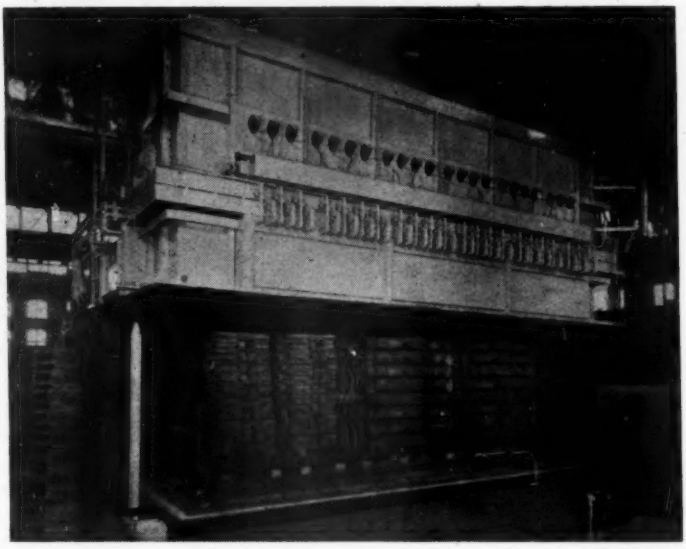

FIG. 1.—FURNACE BEING PLACED OVER CHARGE. APPROXIMATE CHARGE WEIGHT, 22 TONS. EASTERN MALLEABLE IRON COMPANY, WILMINGTON, DELAWARE.

During October, 1943, preliminary developments on this project were started with the co-operation of General Motors Corporation, for the equipment of a new malleable foundry at Danville, Illinois, for the manufacture of rear axle enclosures, differential enclosures, hubs and brake housings for heavy Army lorries.

Mr. Carl Joseph, metallurgical engineer for the

Malleablising Iron Castings

Saginaw Malleable Iron Division of General Motors Corporation, who, it will be remembered, presented the American Exchange Paper to the 1943 conference of the Institute of British Foundrymen, co-operated with Lee Wilson designing engineers on preliminary trials in a Lee Wilson furnace at the Otis works of Jones & Laughlin Steel Corporation, Cleveland. The results were so successful that an installation of 19 Lee Wilson malleablising furnaces, with 25 bases, were installed at the Danville plant, and shortly afterwards this lead was followed by the Albion Malleable Iron Company, of Albion, Michigan, who installed six furnaces of similar type.

FIG. 2.—CHARGE OF HEAVY REAR AXLE HOUSINGS BEING REMOVED AFTER MALLEABLISING. NOTE USE OF SPECIAL HOIST TO LIFT SKID WITH CHARGE FROM BASE. EASTERN MALLEABLE IRON COMPANY, WILMINGTON, DELAWARE.

General Jobbing Trade Requirements

Further development work was then conducted with the Eastern Malleable Iron Company, of Wilmington, Delaware, particularly relating to malleablising of small, medium sized and large castings, in the same charge, in order to meet general jobbing trade requirements. These tests were conducted at the Carnegie-Illinois Steel Corporation, Irvin Works, Pittsburgh, and also proved successful. As a result, the Eastern Malleable Iron Company then placed an order for their first unit. All these furnaces have been in successful operation for over a year, and several other major installations are in contemplation.

In the early concept, it was considered that with a completely gas-tight enclosure in the bell-type furnace the carbon in the steel would combine with the available oxygen of the initial atmosphere, and in the absence of additional oxygen form an atmosphere high in carbon monoxide, which would be completely protective against scaling.

The Lee Wilson bell-type furnace, radiant tube fired, appeared ideal for just this type of operation. Work had previously been done on developing a furnace completely gas-tight, for use in the annealing of high carbon steels with nitrogen atmospheres, and so consequently it is a furnace of substantially the same type which is now used in the malleable field, as shown in Figs. 1, 2 and 3.

Accelerated Cooling

Fig. 4 shows a typical chart taken from one of the furnaces at Saginaw malleable plant. The charge is raised up to 950 deg. C., though annealing temperature may vary with the silicon content between 900 and 950 deg. C. Maximum temperature is held for periods varying from 20 to 25 hrs. in order to effect a thorough dispersal of temper carbon throughout the casting sections. The charge is cooled as rapidly as possible, down to 760 deg. C., and is equalised until all thermocouples read uniformly. The general practice in the United States is to remove the furnace proper from the load at maximum temperature and to apply air blast through the load, thus effecting rapid cooling to the desired level.

Charges up to 20 tons have been quenched by this method in 21 min. The furnace is then replaced over the charge to effect equalisation, after which the charge is slowly cooled to approximately 700 deg. C. The charge is then uncovered by removing the furnace and the castings may be removed from the base. In the quenching process the high carbon monoxide atmosphere is changed by admission of air, but it has been found in practice that sufficient additional atmosphere is formed in the equalising and slow cooling process to an extent which restricts the formation of oxide film to a negligible amount.

The Lee Wilson radiant tube fired furnace is adaptable for any type of industrial gas which may be available, the overall furnace efficiency in the heat input phase exceeds 50 per cent., in addition to which great economy is effected by the elimination of pans and packing materials, increasing the weight of the effective charge and reducing fuel consumption, and, proportionately, costs per ton of castings annealed. Fuel

consumption figures vary from 4,500,000 B.T.U. to 6,000,000 B.T.U. per ton of castings annealed. In this malleablising practice total time cycles vary from 65 to 94 hrs., according to silicon content, and experience is that the fuel consumption is never more than one-third, and often as low as one-quarter, of that required by conventional pan and packing methods of annealing.

This important fuel saving is naturally one of the most interesting features of this furnace application, and American foundry engineers are also greatly impressed with the absence of packing materials and general cleanliness that can exist in an annealing department, as compared with the older installations. This will be very evident from the illustrations, which indicate that the degree of cleanliness maintained with this new annealing process compares favourably with that of the modern machine shop.

FIG. 3.—VIEW OF ANNEALING CHARGE, WESTERN HALF OF BUILDING. TOTAL INSTALLATION: 19 FURNACES, 24 BASES. SAGINAW MALLEABLE IRON DIVISION, GENERAL MOTORS CORPORATION, DANVILLE, ILL.

Wide Flexibility

The wide flexibility of these installations appeal also, in that many different types of castings and forms of loading may be accommodated in the same charge with satisfactory results. It is found in practice that the Lee Wilson radiant tube bell-type furnace meets, flexibly, various programming demands, and possesses many advantages over the long continuous furnace, which must be maintained at high constant production throughput. After more than a year's service, physical examination of these furnaces shows that the radiant tubes appear to be in as good condition as when originally installed.

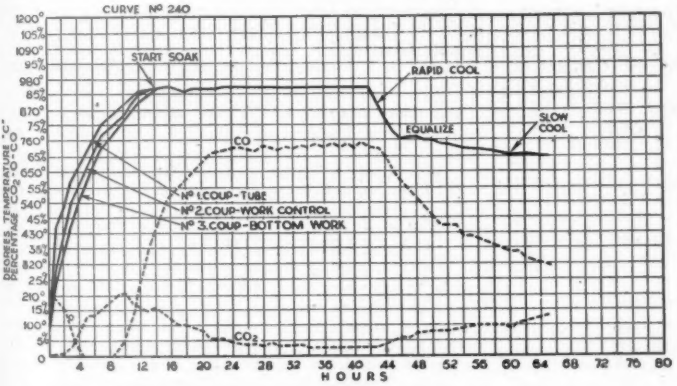

FIG. 4.—TYPICAL CHART TAKEN FROM A FURNACE AT THE SAGINAW MALLEABLE IRON DIVISION, GENERAL MOTORS CORPORATION, DANVILLE, ILL.

The automatic temperature control of the furnace is effected by thermocouples placed within the actual charge, so that the true temperature readings are always obtained, in addition to which the temperature of the radiant tube elements is similarly automatically controlled and maintained within optimum temperature limits, thus ensuring long, satisfactory and economic life of these heating elements. This type of furnace has become highly popular with workmen in the foundry annealing sections as well as with managements, due to their flexibility and cleanliness, in addition to which savings exceeding £2 per ton of castings annealed have been effected, with a reduction of rejects due to the great uniformity and control of the process.

In installations where no crane is available, structural steel frame

(*Continued overleaf, column* 2.)

FOUNDRY CLASSES IN LANCASHIRE

SUCCESSFUL FIRST YEAR

Many readers will recall that a year ago the Manchester and District Ironfounders' Employers' Association and the Institute of British Foundrymen working in close co-operation arranged for foundry classes to be started at Warrington Technical Institute, St. Helen's Municipal Technical College, and Openshaw Technical School. These classes have proved very successful, and a good percentage of apprentices have taken the opportunity afforded to them to advance their knowledge of metallurgy and foundry work and so to equip themselves to become skilled craftsmen. In all three centres the second year of the course is now starting, and a new first-year class is being assembled, and it is incumbent on all employers to give every possible encouragement to their apprentices to attend.

The classes at Warrington and St. Helens are combined day and evening classes and in all cases employers are paying the apprentices' wages for the time spent at the day classes, provided that the boys themselves are putting in the evening attendances in addition. Employers are notified by the school authorities of absentees. The Widnes group of the Manchester Association have given four prizes in each of the two first-mentioned centres which come within the area of their group, the first prize being £3 3s.; the second prize £2 2s. and the third prize £1 1s., with an additional prize of £1 1s. to the apprentice who, in the opinion of the school, has made the best progress during the session regardless of his final position at the end of the session. The prizes this year have been awarded as follows:—

Warrington centre:—First prize, W. Burton, of James Smethurst & Son; second prize, D. Smith, of Lancashire Steel Corporation, Limited; third prize, A. Ellis, of Widnes Foundry & Engineering Company, Limited, special prize, J. Behan, of James Smethurst & Son.

St. Helens centre:—First prize, M. W. Collins, of John Varley, Limited; second prize, G. Robinson, of John Pritchard & Sons, Limited; third prize, J. Entwistle, of W. Woodcock, Sons & Company, Limited; special prize, G. Robinson, of John Pritchard & Sons, Limited.

In the Openshaw centre two prizes have been awarded by Mr. Leslie Mortlock, of Hill & Son (Manchester), Limited, and these have been awarded to A. Robinson, of National Gas & Oil Engine Company, Limited, and C. Standish, of Brooks & Doxey, Limited.

Employers' Loyal Co-operation

Credit is due not only to the youths who have attended the classes, but also to the employers who have co-operated so loyally in the scheme and allowed their apprentices to be absent with pay. The promoters are sure that nothing but good can come out of the scheme provided that the employers continue to offer the facilities to the youth and that the youths themselves continue to attend the classes. It is hoped, therefore, that all foundry employers will support this and similar schemes to the utmost of their capacity.

The dates for the commencement of classes at the schools for the 1945-46 session are as follow:—Warrington, week commencing September 24; St. Helens, week commencing September 24, and Openshaw, week commencing September 17. Applications for enrolment should be made, if possible, during the week preceding the opening of the schools, or as soon as possible after the above dates.

BOOK REVIEW

"Commodity Control" (2nd Edition). By J. Bray Freeman, barrister-at-law. Published by Butterworth & Company (Publishers), Limited, Bell Yard, Temple Bar, London, W.C.2. Price 21s. net.

The first edition of this book which appeared in February, 1943, is now brought up to date. Since that date the number of stututory rules and orders has increased very considerably, whilst, on the other hand, on May 9, 1945, more than one hundred were in whole or in part revoked. It is commendable that the binding of the book contains a pocket, for herein one can file new Orders and cancellations. The book, it will be recalled, enumerates all the S.R. and O's. for all commodities, except food, and epitomises law cases which have a bearing on their impact.

The reviewer discovered a phrase, which seems to be of prime importance, as the Orders which have been made apply not only to the Defence of the Realm Act but are extended to ensure the continuance in peace of the essential services for the proper functioning of the State. Thus, these controls may be an integral part of the business life of this country for a prolonged period. Quite a few now operative apparently date back to the last war and the 1920's. It is interesting to learn that there are 67 Orders for the control of paper and 37 for iron and steel. "Commodity Control" is still a book of major importance to those in "nominal" control of manufacturing concerns.

V. C. F.

THE FIRST MEETING of the new session of the London branch of the Institute of British Foundrymen will be held on October 3, when members will visit the Charlton Works of J. Stone & Company, Limited, Deptford, London, S.E.14. This will be followed by tea and the presidential address by Mr. A. J. Murphy.

MALLEABLISING IRON CASTINGS

(*Continued from previous page.*)

and hoist may be mounted over the furnace, no special foundations being required. The general consensus of opinion amongst American foundry operators is that this type of equipment will be in universal use in malleable foundries immediately war conditions permit of the renewal of general plant construction. The Incandescent Heat Company, Limited, of Smethwick, are the sole licensees and manufacturers of the Lee Wilson system, which incorporates this interesting development.

TENTATIVE RECOMMENDED METHODS FOR CASTING CAST-IRON TEST-BARS

Discussion on a Paper presented by Dr. A. B. Everest, chairman of Sub-committee T.S.4, at the annual meeting of the Institute of British Foundrymen, Mr. P. A. Russell presiding. The Paper was printed in our issue of June 28.

MR. H. MORROGH, speaking as one who examined test-bars made by a very large number of different foundries, said that, in spite of the comments made by foundrymen concerning the difficulties of making sound castings, he had for long been of the opinion that test-bars were among the most difficult castings to make sound.

The defects in test-bars could be classified broadly into two types; on the one hand, there were porosity defects, and on the other hand there were defects due to mechanically entrapped slag and sand. The recommendations made in the report covered the second group of defects fairly adequately. But with the increase in the production of low-carbon irons—by which he meant irons having total carbon contents of the order of 3 per cent. and less—he felt that the adoption of the recommendations made in the report did not permit of the production of a test-bar completely free from porosity throughout its entire length. Troubles due to porosity were not immediately apparent in a bar that was tested in transverse. The bars dealt with in the report were designed primarily, he believed, for testing in transverse; but more and more the halves or portions of the bars were being tested in tensile, they were increasingly subjected to more newly-developed impact tests, and probably would be required for fatigue testing, and so on. Those other tests brought out porosity which was not normally revealed in the transverse test; and porosity was nearly always present, and was disclosed if a sufficiently marked search was made for it.

B.S.S. Specifications

Mr. Morrogh felt that the test-bars as specified in the British Standard Specifications were too long to allow of adequate feeding being provided at the centre when using relatively low-carbon irons. When a foundryman discovered that he could not feed a casting properly he would claim that the design was incorrect, and, if possible, the job would be redesigned. That led Mr. Morrogh to suggest that, whilst appreciating that the work described in the report represented an important step forward, that work should be continued to the extent of examining the existing British Standard Specifications with a view to shortening the transverse bars. He did not know off-hand what factors had been responsible for the decision that the 1.2-in. bar, for instance, should be tested at 18-in. centres, but he felt that the bars could be reduced considerably in length; that would permit of more adequate feeding, and would also enable the bars to be cast horizontally much more easily, with feeding from both ends of the bars. Finally, he said that his comments were made in a purely speculative manner, but he felt that at some time the problem would have to be tackled from that point of view.

DR. A. B. EVEREST, commenting that Mr. Morrogh had had a very great deal of experience of the casting of test-bars, asked whether it was the practice to cast the bars in shorter lengths in the foundry of the British Cast Iron Research Association.

MR. MORROGH replied that the existing specifications still had to be met, so that it was necessary to cast the bars in long lengths. But some experimental work was in hand in an endeavour to support the views he had expressed, using a short bar and casting horizontally. They had a method very similar to that suggested in Fig. 2, and they had used with reasonable success the method illustrated in Fig. 1.

DR. EVEREST asked if he suggested seriously that the bars could be cast satisfactorily horizontally.

MR. MORROGH replied that he did; but he was thinking of the short lengths, of course.

MR. J. E. O. LITTLE asked whether the recommendations for casting test-bars had been arrived at by the sub-committee after trying various methods of casting them, or whether they represented collective opinions. The reason he asked was that in the Meehanite Research Institute they had been concerned about cast-iron bars, and last year several licensees had cast sets of bars by different methods from one ladle of metal. One surprising result was that, in the case of the B.S.S. 1.2-in. bar, cast vertically and horizontally, although the horizontally-cast bars might not give the very highest results, the "spread" was far less than in the case of the vertically-cast bars; *i.e.*, it was shown quite definitely that the horizontally-cast bars were more uniform than the vertically-cast.

Individual and Collective Experience

DR. EVEREST replied that the recommendations for the casting of test-bars were not based on actual experiments by the sub-committee, but on the collective experience and opinions of the members. At least one member of the sub-committee had made the point that the horizontally-cast bars gave the more consistent results, but that with the vertically-cast bars one usually obtained results a ton or so per sq. in. higher than with the horizontally-cast. The feeling was that the bars should be cast vertically if one could establish a method which would give consistent results.

MR. DONALDSON asked if the sub-committee had considered the cast-on test-bar, because engineers who used castings often specified that the bars must be cast on; otherwise they would not accept that the test-bar was made from the same metal. He contended that that was a most unfair method, especially for a casting weighing 20 tons or so; and he wondered whether anything had been done to impress upon engineers that it was detrimental to cast a test-bar attached to the casting, or, if not, whether publicity could be directed to the matter.

Casting Cast-iron Test-bars

DR. EVEREST said the sub-committee had purposely left alone the problem of the cast-on bar, for it was a very knotty problem. But the members were against the use of cast-on bars, and he believed it was the general opinion that, as the result of the efforts of individual foundrymen in tackling inspectors, and so on, the latter were being educated to accept the separately-cast bar rather than the cast-on bar; the tendency was rather in that direction, and industry was slowly getting away from the cast-on bar. That tendency was also dependent upon developing more sympathy and understanding as between inspectors and foundrymen, and he believed the inspectors were beginning to trust the foundrymen more.

MR. G. L. HARBACH said he believed the British Standard Specification recommended the cast-off bar, but B.S.I. 321 and 786, Clause 5, under "Provision of Test-bars," reads: "The engineer or purchaser may specify cast-on bars where the design of the casting and method of running permit."

Plea for Standard Specification

MR. E. H. BROWN urged that it was time that foundrymen pressed for a standard specification which specified a definite and concrete method of casting test-bars—and that need not be confined to cast iron. Within the last six months he had had occasion to check test-bars which had come from four or five different foundries, all relative to the same nominal specification and for the same particular type of casting, and the results obtained from those bars, by chemical and physical analysis, had been very similar; but the actual test figures for those bars had varied very widely. In most cases tensometer figures had been obtained from the actual castings and the results were very comparable; but the test-bars, cast in nearly every case by different methods, gave results which were not comparable. It was time that specifications laid down definite and concrete methods to which foundrymen should work, and not merely recommended methods. He believed that about 12 years ago the Italians had tried to enforce a specified method, and that in respect of Government researches it was enforced; but in that case they had tried to cast a loose bar in the same mould as the casting itself, a dry-sand/oil-sand core being placed in the corner of the main mould. That, of course, was open to other queries. However, his own feeling was that a test-bar should represent the metal used and not the actual casting.

Another comment by Mr. Brown was that the sub-committee was recommending two widely divergent methods of casting. One was by bottom pouring and the other by top pouring. He, personally, had a very strong feeling that the top-poured bar would give, generally speaking, a higher standard of test results than the bottom-poured bar. If the sub-committee had to recommend anything, why not adhere to one method, instead of offering the two totally different methods?

He agreed that the results obtained from horizontally-cast bars were generally more consistent than those obtained from the vertically-cast; if three or four bars were cast by each method, the test figures for the vertically-cast bars would show a wider spread than those for the horizontally-cast.

MR. MCRAE SMITH expressed his interest in Mr. Morrogh's remarks that test-bars were often unsound. After all, he said, the real purpose was to produce sound bars. It was not so much a question of whether one method would give higher mechanical results than another. He felt that Mr. Morrogh had classified the defects rightly. However, he was rather surprised to hear that long test-bars could not be produced free from porosity. Quite honestly, he could not see why that should be so, provided feeding heads were used as recommended by the sub-committee, and provided also that top pouring was used. In casting a hydraulic ram of about 20-ft. length and 12-in. dia., cast solid, one usually poured it from the top in order to ensure that it solidified progressively from the bottom upwards. Surely the same consideration applied to a 27-in. long test-bar.

He was gratified that the sub-committee had put forward dry-sand test-bars run from the top. But, whilst appreciating that they had to put forward some alternative for green sand, to fulfil the conditions of the British Standard Specification, he was not at all sure that top running in green sand was not better than bottom running, but it was perhaps best to suggest both methods.

With regard to recommendation No. 5, dealing with mould dressings, he suggested that the first part of the paragraph was perhaps rather badly worded. It might with advantage be rearranged, perhaps to state that oil-sand core blocks need not be blacked, but that they may be blacked if founders so desired. With regard to the statement concerning what might be called "non-blacking dry sand," he suggested that the reference to 10 per cent. mineral blacking should be put into general terms and not particularised. The sub-committee was to be highly commended on its work.

Test-bars Made in Loam

MR. J. C. CHARLTON commented that no reference was made in the report to test-bars made in loam. He was producing castings which varied in thickness from ¼ in. to 12 in. The strength of the material in work with such a change of section was bound to vary and test-bars cast on at different places give different results. These results were not comparable and were not truly representative of the material. Test-bars cast separately under standard conditions would give results that could be compared. If the sub-committee could succeed in persuading the various inspecting authorities to accept a standard type of test-bar which was not attached to the castings, then they would be doing good work.

DR. EVEREST replied that the sub-committee had not considered loam, but he agreed that it should be considered. As to the relationship between the strength of the test-bar and the strength of the casting, he said there had been a few differences with

various inspectors during the war, and he felt that the test-bar must be accepted as representing the metal in the casting, and not the casting itself. A certain amount of work had been done during the war in correlating the strength of test-bars with test-pieces cut from the castings, and in his experience there was no relationship whatsoever. In some work connected with brake drums, one could determine the quality of the metal from the separately-cast test-bar, but it depended on the design of the brake drum and the grade of metal employed as to whether one obtained high or low strength from a sample cut from the casting.

MR. CHARLTON commented that the Admiralty would accept 9 tons for the cast-on bars, but other purchasers would insist on double that figure.

DR. EVEREST said that the cast-on bar would generally give lower strength than the separate bar.

MR. J. F. CHAMBERS said the sub-committee had made a good start, even though its terms of reference were perhaps rather unfortunate. It had started off to consider the best way to make the B.S.S. bar, whereas it would have been better to have set out to find the best way to make a bar which gave the truest representation of the metal. From that point of view he supported the view of Mr. Morrogh, that the transverse test-bar was too long in relation to its diameter. His own preference was for a separate tensile bar which could be cast horizontally and fed from both ends.

Dimensions of Test-bars

DR. EVEREST mentioned that Mr. P. A. Russell was forming a new sub-committee to consider the specifications, and one would like to suggest that the agenda should include the consideration of the dimensions of the test-bars and the desirability thereof, or otherwise. It would have to consider whether one could obtain a true transverse test on, say, two-thirds of the span of the present test; if so, there might be an all-round reduction of length.

MR. BEN HIRD recalled that years ago the late Mr. John Shaw and others had worked on a test-bar committee, and had started with the definite proposition that the bar should be representative of the metal. He did not see how, from the foundry point of view, it could be said that a test-bar was representative of the strength of a casting, bearing in mind the complicated structure of many castings. An attempt had been made by the French to trepan a piece off a section of a casting to represent the actual metal in the casting, but it was an absolute failure; Mr. Jolley had taken trepanned pieces from certain bosses and other sections of castings, and in some cases they could be broken between one's fingers. The best that could be done was to try to agree on a standard method of casting a bar, and to condemn as far as possible the old-fashioned method of casting bars on to large castings. The latter was not a fair proposition, and he hoped the sub-committee would try to settle the controversy with regard to test-bars by putting forward something definite which, although it might not meet everybody's requirements, could be made more or less standard.

MR. S. R. MILNER, referring to strainer cores, said he imagined their purpose was to retain the slag at the top and to allow the clean metal to be admitted into the bar. He and his colleagues had experienced some little difficulty recently; but they were not casting in the manner recommended in the report. They had two test-bars in a box, with stoppers over the top of the feeding head; the bush was filled up and the stoppers were taken out, so that the metal filled into the bar. But whereas one bar had usually been fairly sound and had generally given fairly high tensile results, the other had sometimes had numerous inclusions and had naturally given lower tensile results. They intended to study the problem in more detail by checking the composition of each bar. Tests recently had shown one bar to give exceptionally high results, and the other to give exceptionally low results. He would suggest using the strainer cores instead of the stoppers in an effort to obtain more uniform results.

Quoting the sub-committee's recommendation that for medium and light work the temperature of pouring should be the same as for the parent casting, and that for heavy work the temperature should be as high as conveniently possible. Mr. Milner asked Dr. Everest for more detail as to what was meant by the terms "heavy work" and a temperature "as high as conveniently possible."

DR. EVEREST said the committee had in mind that the test-bar for heavy work was very often of substantially smaller section than the bulk of the casting, so that one could get the metal quickly into the casting and very often cast it at a lower temperature than that at which one would cast the bars to ensure the production of sound and clean bars.

Scope of New Sub-committee

The CHAIRMAN (Mr. P. A. Russell, B.Sc.), winding up the discussion, said there had been one or two adverse comments made with regard to the British Standard Specifications as the result of years of experience of working them; and industry had had much more to do with test-bars under war conditions than in peacetime, so that a new sub-committee of the Technical Council had been formed, with very wide terms of reference, with power to examine the scope and operation of the present specifications and to make any recommendations that were considered necessary. It was hoped that the sub-committee would be very widely representative; they would probably make suggestions and would try to get around to the branches of the Institute in order to obtain as wide a view as possible of the working of the specifications. The discussion on the report of Sub-committee T.S.4 had indicated that there were very differing views on the matter and that there were many difficulties. It had been the policy of Sub-committee T.S.4 to prefer the separately-cast test-bars, but it had not yet reached the stage at which it could persuade the British Standards Institution to rule out entirely the cast-on bars.

Speaking of his own experience, Mr. Russell said he had been making castings regularly in iron having only about 2.7 per cent. carbon, under Government

Casting Cast-iron Test-bars

inspection. The practice was to cast the ¼-in. dia. transverse bars on end, and to cast separately the 6-in. long bars for tensile tests. But he had not seen any evidence of porosity in the longer bar being any worse than in the 6-in. bar, although the particular cast iron used was very liable to that type of trouble. The arrangement shown in Fig. 1 was used by his company in green sand as well as in dry sand, and he had a strong preference for the top pouring as against the bottom pouring.

When the report of Sub-committee T.S.4 was presented to the Technical Council originally it was entitled "Recommended Methods for Casting Cast-iron Test-bars"; later the word "Tentative" was put in to soften the blow a little. But the only comment made in the course of the discussion which had a bearing on that was that methods should not be merely "recommended," but should be "specified." So that he had derived sufficient encouragement from the discussion to warrant deleting the word "Tentative"; and after a little further consideration by the sub-committee of the points that had been raised, he felt the report could very safely be entitled "Recommended Methods . . ." Finally, Mr. Russell expressed gratitude to Dr. Everest and his sub-committee for their work and for having presented the report.

DR. EVEREST, in his response, said that, so far as he was aware, there had been no wholesale condemnation of the methods recommended in the report; and unless there were any serious condemnation later, the report would go forward as representing the official recommendations from the Institute.

Written Discussion

MR. M. M. HALLETT wrote:—Any attempt to standardise the methods of producing test-bars to meet the requirements of B.S.S. 321 and 786 is to be welcomed, and the main recommendations of the sub-committee appear to be based on sound principles. The writer's preference is for top-poured vertically-cast test-bars of the type suggested in Fig. 1, incorporating a strainer bush. The sub-committee has clearly been thinking mainly of ordinary grey-iron practice, but it should be borne in mind that sound test-bars are also required in alloys such as the high chromium ferritic irons, which are more difficult to cast sound. It would be well, therefore, to emphasise that the feeding heads suggested in recommendation No. 4 are to minimum dimensions. Foundries requiring to produce sound test-bars in a range of difficult irons would be well advised to increase the size of the feeding heads, and thus to err on the safe side for all castings.

The strainer core should be so located that it does not interfere with the feeding action. This is not made quite clear in Fig. 1, but presumably the sub-committee in this sketch are regarding only that portion of the head below the strainer core or strainer bush as the part which is effective in promoting feeding, and which should, therefore, conform with the recommended size.

DORMAN, LONG APPOINTMENTS

THREE DIRECTORS AND GENERAL MANAGERS

Dorman, Long & Company, Limited, announce the appointment of three directors and general managers who will be responsible to the managing director for various sections of the company's activities.

Mr. D. R. Brooks will be responsible for Dorman, Long colliery interests in Durham County. Mr. A. MacLeod will have charge of iron and steel works, and Mr. J. A. Millar is to be concerned with other departments and interests.

The new directors and general managers have all progressed through the Dorman, Long organisation from comparatively minor positions. Last November they were, with other senior officials, appointed special directors of the company, and their appointment as directors and general managers is in pursuance of the company's policy of making promotion to the highest executive positions open to employees with the necessary capacity and experience. It is the considered view of the Dorman, Long board that opportunity of personal progress for their employees is an important factor in the maintenance of co-operation between management, staff and workers and a stimulus to individual effort.

Mr. MacLeod, who is a Middlesbrough man, joined the company in 1908 as an apprentice in the engineering department of the Britannia Works, Middlesbrough, later gaining considerable experience at other works in this country and on the Continent. He was appointed commercial manager in 1941.

Mr. Brooks became manager of the Spawood Ironstone Mine in 1914, and, after experience as manager of several of the company's collieries, has been chief agent for the Durham group since 1935.

Mr. J. A. Millar, who went to Bolckow, Vaughan & Company as a young chartered accountant in 1927, was works accountant at Dorman, Long & Company's Cleveland Works before becoming chief accountant in 1933 and, later, treasurer. He is also a director of Redpath, Brown & Company, Limited, and the Tees Side Bridge & Engineering Works, Limited.

MOTION STUDY EXHIBITION

An exhibition of a selection of jobs which have been motion-studied is being arranged to show the potentialities of motion study and its application to industry as a whole. The exhibition has the support of the President of the Board of Trade and the Minister of Supply and of Aircraft Production. It will be held at the Carlton Hotel, Pall Mall, London, S.W.1, from October 3 to 12. Admission will be by invitation card, which can be obtained on application to the secretary, Production Efficiency Board, Ministry of Aircraft Production, I.C.I. House, Millbank, London, S.W.1.

THE MINISTRY OF WORKS announces that all restrictions on the use of bitumen, etc., for pipe coating are withdrawn.

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NEWS IN BRIEF

THE WOLVERHAMPTON BRANCH of the Institute of Welding are holding an inaugural dinner at the Crown Hotel, Albrighton, at 7.15 p.m. on Wednesday next.

FRENCH STUDENTS of the Ecole Polytechnique are to attend the course on quality control methods arranged by the Ministries of Supply and Production in September.

DARLINGTON GAS COMMITTEE have accepted the tender of the Whessoe Foundry & Engineering Company, Limited, Darlington, at £64,000, for the erection of a new gasholder, with a capacity of 3,000,000 cub. ft.

ALL TYPES OF CONTRACTORS' PLANT may be purchased without a "permit to purchase" from the Ministry of Works after September 30. Prospective purchasers should, therefore, place their orders direct with manufacturers, states the Ministry.

"INDUSTRIAL APPLICATION OF AUTOMATIC SUBMERGED ARC WELDING" is the title of a Paper to be given by Mr. R. Sillifant to the Sheffield branch of the Institute of Welding at the Royal Victoria Hotel, Sheffield, at 6.30 p.m. on Thursday next.

GUTHRIE, ADAMS & COMPANY have established themselves in business at 4, Leighton Lane, Leeds, 1, as analytical chemists, metallurgical and foundry consultants. Mr. J. Guthrie was for many years on the staff of Keighley Laboratories, Limited.

A PAPER ON "Welding, Past, Present and Future," will be presented by Mr. A. Stephenson and Mr. D. Llewellyn to the East Scotland branch of the Institute of Welding at the Heriot Watt College, Chambers Street, Edinburgh, at 7.30 p.m. on September 28.

MR. WALLACE B. PHILLIPS, president of the American Chamber of Commerce in London, said recently that American manufacturers had not lost faith in Britain and were anxious to take a more active part in its economy. On an average, the American Chamber of Commerce in London received 25 inquiries a week in regard to possible trade developments.

THE NATIONAL UNION OF MANUFACTURERS has sent a communication to the Chancellor of the Exchequer asking him to review the heavy burden of direct taxation upon industry in the presentation of his next Budget. This, it is pointed out, would enable the productive energy of the nation to contribute more effectively to the full employment programme of the Government.

A PAPER on "Recording Engineering and Other Work by Stereoscopic Photography" will be presented by Mr. R. Peel to the Association of Scientific Photography at the Alliance Hall, Westminster, London, S.W.1, at 6.30 p.m. on September 27. The Paper will deal with the taking of negatives, preparation of prints and the processes used for the production of anaglyph prints by the "Carbro" method.

IT HAS BEEN REVEALED that work on the 40,000-ton battleship "Lion," laid down in 1939 at the Walker-on-Tyne Naval Yard of Vickers-Armstrongs, Limited, was suspended early in the war. There is a possibility that the structure, still on the stocks, will be dismantled. The "Lion" was ordered under the 1938 programme, and it was because of the urgent need for other naval craft that work was stopped.

VISCOUNT DAVIDSON, president of the Engineering Industries Association, speaking at Birmingham on September 11, said that Britain was short of factories, particularly modern factories in which operators could work under the best conditions and enjoy full amenities. New building could not be done quickly with the need for houses. He urged that some measure of new factory building should rank equally with house building, for it would be of little use to give operatives good houses to live in if they had no places to work in.

SIR W. MURRAY MORRISON, chairman of Aluminium Corporation, Limited, has confirmed that aluminium production at Dolgarrog has ceased. Owing to temporary power supply arrangements the company had been able to help the war effort by producing aluminium at Dolgarrog. The power supply came to an end in the spring of this year, so production ceased. The board felt that any power which they could purchase would be at a very high rate, which, although permissible during the war period, was no longer a question of practical politics.

OBITUARY

MR. WILLIAM JAPP, Glasgow agent of the Standard Piston Ring & Engineering Company, Limited, died recently.

MR. JOHN W. HARRISON, a Sunderland steel and tool merchant, died recently at Newcastle-upon-Tyne. He was 66.

MR. JAMES BRYAN, manager of the foundry sales department of the Staveley Coal & Iron Company, Limited, has died suddenly. He was 62.

MR. GEORGE WILLIAM BIRKETT, who died on September 8, aged 72, was a director of Francis W. Birkett & Sons, Limited, brassfounders, of Cleckheaton.

MR. MAX FALK, a director and late chairman of Falk, Stadelmann & Company, Limited, manufacturers of heating and cooking apparatus, etc., died recently, aged 78.

MR. E. LANCASTER-JONES, Keeper of the Science Museum Library since 1938, died at Maidenhead on September 9, aged 54. He joined the staff of the Science Museum in 1920.

WOLVERHAMPTON STEEL COMPANY ACQUIRED BY THOS. W. WARD

Thos. W. Ward, Limited, Albion Works, Sheffield, have purchased from the receiver and manager the Wolverhampton Steel & Iron Company, Limited (in liquidation), Osier Bed Works, Wolverhampton, as a going concern. The works will be continued in full capacity, trading as the Wolverhampton Steel & Iron Company (proprietors, Thos. W. Ward, Limited).

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PERSONAL

MR. L. W. SANDERS has been appointed chief metallurgist to Lake & Elliot, Limited, of Braintree, Essex.

MR. F. W. DUGDALE, of S. P. Austin & Sons, Limited, Sunderland, has been re-elected president of the Sunderland Chamber of Commerce.

MR. G. W. LACEY has relinquished his appointment as Controller of Light Metals in order to rejoin the British Aluminium Company, Limited. He is succeeded by MR. C. G. MCAULIFFE.

MR. R. K. PIERSON has been appointed chief engineer of the aircraft section of Vickers-Armstrongs, Limited. MR. G. R. EDWARDS has become chief designer at the company's Weybridge works.

MISS CAROLINE HASLETT, who was adviser to the Coalition Government on woman-power, has been elected a vice-president of the Royal Society of Arts, the first woman to be appointed to this position.

MISS BRONS, the well-known Dutch foundry owner, has written friends in this country that she has come through the occupation with considerable discomfort, but with no lasting hurt, and has reopened the business.

MR. J. P. HUMPHRIES is resuming his duties next month as a technical representative of Foundry Services, Limited, Birmingham. He will assist the London area manager, Mr. A. E. King. Mr. Humphries has served in the R.A.F. for the past six years.

MR. J. G. W. LOWE, joint managing director of Sterling Foundry Specialties, Limited, of Bedford, is at present in the United States on business. In addition to visiting his firm's associated companies, Mr. Lowe intends seeing some of the more prominent American foundries.

MR. ROBERT D. BURN, who has been appointed Director of Non-Ferrous Metals under the Raw Materials Department of the Ministry of Supply, was formerly assistant manager at the Bede Metal Company's works at Hebburn. In 1933 he left to take up an appointment with the Mond Nickel Company, Limited, in London. In 1939 he was appointed Deputy-Controller at the Ministry of Supply for non-ferrous metals.

MR. F. P. D. SCOTT is resigning the chairmanship of the Underfeed Stoker Makers' Association. He also has resigned his position as managing director of Prior Stokers, Limited, but will remain in active touch with the company. Mr. Scott takes these steps because of his commitments with the Morgan Crucible Company, Limited. LIEUT.-COL. A. DE CHIMAY and MR. A. D. MURRAY have been appointed joint managing directors of Prior Stokers, Limited.

MR. F. G. BIRD has been appointed manager and director of the companies in the Jarvis Industries Group (Sir W. G. Armstrong Whitworth & Company (Ironfounders), Limited, Armstrong Whitworth & Company (Pneumatic Tools), Limited, and Jarrow Metal Industries, Limited). MR. J. W. MILLS has also been appointed a director of these companies. As recently announced, MR. W. SCOTT, J.P., has been appointed managing director of the Jarvis Industries Group, in succession to the late Major T. G. Bird. Mr. Scott has been a director of the companies for many years.

Wills

BROWN, J. W., of Middlesbrough, iron and steel merchant	£23,828
BOGOD, W. M., of W. & J. Bogod & Company, Limited, engineers, Cardiff	£41,496
LIDDELL, ANDREW, of Sutton, late a director of the South Wales Tinplate Corporation, Limited	£18,790
NEWEY, LIEUT.-COLONEL W. G., a director of Newey Bros., Limited, and Newey & Tayler, Limited, Birmingham	£24,178
NAYLOR, C. T., of Golborne, Lancashire, chairman and managing director of Naylor Bros., Limited, colliery engineers	£52,676

DAVY & UNITED ENGINEERING

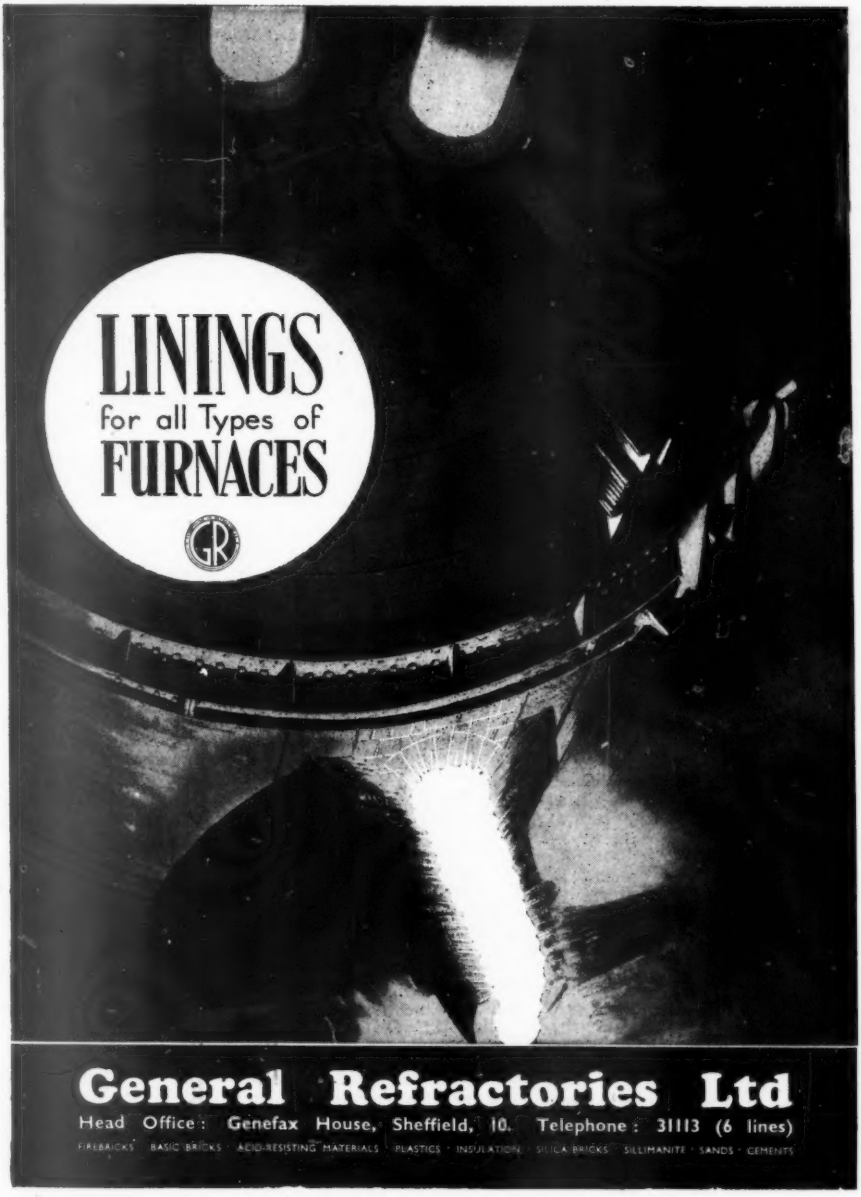
At the annual meeting of Davy & United Engineering Company, Limited, Mr. D. F. Campbell (chairman) said that there was a vast programme of reconstruction to be carried out in the iron and steel industry. In order to put themselves in a better position to undertake a substantial portion of this work, they were reconstructing their Park Ironworks in Sheffield and extending the Glasgow works. Plans were being made for a substantial extension of their Darnall works in Sheffield and when these were sanctioned and completed they would have well-balanced manufacturing capacity. The directors intended that Davy & United would not only have excellent manufacturing facilities, but also maintain a staff of designing engineers equal to any foreign organisation, and to this end the education and training of Service men and new entrants to the industry was receiving the careful attention of the management. It was hoped and expected that the Government and the steelmakers would support their efforts to seize the opportunity now presented to enlarge the scope of their activities so that they might reconstruct their British steelworks efficiently and take advantage of the exceptional circumstances to obtain a fair share of export trade.

CONTRACT OPEN

Any date given is the latest on which tenders will be accepted. The address is that from which forms of tender may be obtained.

Cheltenham—Supply and laying of 2,900 yds. of 5-in. and 3-in. spun-iron mains, complete with specials, fittings, etc. Mr. J. H. Haiste, 4, Queen Square, Woodhouse Lane, Leeds, 2, consulting engineer.

THE INAUGURAL MEETING of the North London branch of the Institute of Welding was held at the Polytechnic, Regent Street, W.1, on Wednesday of last week. A business meeting was followed by a lecture on "Underwater Welding," by W. N. Kemp, A.M.I.N.A., M.Inst.W. Mr. E. Sharratt, B.Sc., Ph.D., 40, Bullsmoor Way, Waltham Cross, is acting hon. secretary of the branch.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Raw Material Markets

IRON AND STEEL

Conditions in the pig-iron trade vary very little from week to week. Licences for low- and medium-phosphorus, refined and hematite irons are being granted freely, and although neither producers nor consumers are carrying more than slender stocks of common foundry irons, recent deliveries suffice for current needs. As more labour is released and the housing drive gathers momentum, it seems tolerably certain that pressure for No. 3 iron will increase, and no doubt this aspect of the situation is receiving the careful attention of the controlling authority.

The demand for finished iron is rising; this is largely due to the quickening flow of orders for best iron from the shipyards. Producers of semi-finished steel are working to the limit of their capacity. Their attention is primarily directed to the satisfaction of the substantial requirements of the sheet mills. This, however, has led to a shortage of billets, which may continue until the arrival of supplies from the Dominions which were recently purchased by the Control. Meanwhile, the re-rollers of bars, strip and sections are carrying on as best they can with the limited deliveries from home producers, supplemented by various classes of defective material.

Although conditions at the plate and section mills are improving, export business is still subject to official restrictions and it is noticeable that most of the specifications reaching the plate mills are for the lighter gauges. The trade in medium-sized joists and sections is on a better scale and collieries are pressing for increased quotas of arches, props, rails, etc. The busiest branches of the steel trade are the rail and sheet mills. Both for home use and for the rehabilitation of transport facilities abroad, the output of all classes of railway material has been stepped up to the highest possible levels, and sheet makers are equally favourably placed. Their commitments already extend well into 1946 and the volume of inquiries still circulating suggests that the peak of the demand has not even yet been reached.

NON-FERROUS METALS

The underlying problem in the non-ferrous metals trade, as in so many other departments of industry, is still the labour shortage. Both orders and materials, with the exception of tin, are plentiful, but execution of these orders is alarmingly slow. Indications from the Continent show a keen desire to secure supplies of copper and other metals for purposes of reconstruction. There is still much fluctuation in the prices of virgin metals in the various trading centres. The copper position in America remains obscure, with an intimation that the United States is unlikely to buy any foreign copper after October. Rumours are abroad of a quick resumption of tin production in the East Indies being possible. During the first half of 1945, consumption of most metals, copper and nickel in particular, was below the corresponding 1944 level. The reduction in munitions demands is responsible for this, and there have since been further cancellations of war contracts.

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Foster & Warren, 247, High Street, Hounslow—Engineers, etc. £500. W. E. Foster and L. D. F. Warren.

Heather Plating Works, The Forge, Moss Lane, Brentwood Road, Romford, Essex. £4,000. T. and E. F. E. Staples.

Rushtons (England), 138, Stamford Street, Stalybridge—Metal depositors, etc. £1,000. R. G. Cooke and B. Workman.

Diamond Chrome Plating Company, Peel Street, Stoke-on-Trent—£1,500. A. E. Waterman, W. E. Bunting and P. Barby.

Palatine Tool & Engineering Company (Surbiton), 64, Brighton Road, Surbiton, Surrey—£200. F. W. Broughton and J. G. Kierman.

Garston Foundry Company, 48, Wellington Street, Garston, Liverpool—Ironfounders, etc. £5,000. R. G. Gaskill and W. R. K. Gregson.

Alumartic, 158, Bishopsgate, London, E.C.2—Manufacturers of and dealers in aluminium and other metal articles, etc. £1,000. E. Sagall.

Whiteley Thomas, 9, South Norwood Hill, London, S.E.25—Ironfounders, engineers, etc. £6,000. S. E. Whiteley, L. J. Thomas and W. P. Banfield.

H. T. Shakespeare, 21, Hermitage Road, Edgbaston, Birmingham—Tinplate and aluminium workers, etc. £2,000. H. T. Shakespeare and G. F. Payne.

W.E.S. (Wolverhampton), 12, Bell Street, Wolverhampton—Electrical and mechanical engineers, etc. £1,000. A. C. and P. M. Bate, T. Thompson and R. P. Chambers.

Elasteel—Manufacturers of railway permanent way materials, etc. £10,000. J. C. Cowen, F. Hewitt, W. H. Newson and L. N. Rawes; H. S. Blythe, 9, Saville Road, Chadwell Heath, subscriber.

Friedman-Athill, 240, High Holborn, London, W.C.2—Manufacturers of and dealers in gas, electric, agricultural, engineering, building, and other equipment, etc. £10,000. G. Hawkes, H. Friedman, and L. C. H. Athill.

KEIGHLEY ASSOCIATION OF ENGINEERS will hold their first meeting of the 1945-46 session at Devonshire Buildings, Devonshire Street, Keighley, to-morrow evening (Friday), at 7.30, when Mr. H. Eckersley, A.M.I.Mech.E., M.I.P.E., will give a Paper on "Negative Rake Milling."